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(71) Applicant: OKI TELECOM [US/US]; 437 Old Peachtree Road, Suwanee, GA 30174 (US).

(72) Inventors: ARAKAWA, Kunio; 4918 Rapids Court, Norcross, GA 30092 (US). LI, Ben; 10730 Pinewalk Forest Circle, Alpharetta, GA 30202 (US). MARTIN, Douglas, Todd; 15050 Thompson Road, Alpharetta, GA 30201 (US). TOKUYAMA, Katsumi; 445 Hackberry Lane, Roswell, GA 30076 (US).

(74) Agents: ISAF, Louis, T. et al.; P.O. Box 720601, Atlanta, GA 30358-2601 (US).

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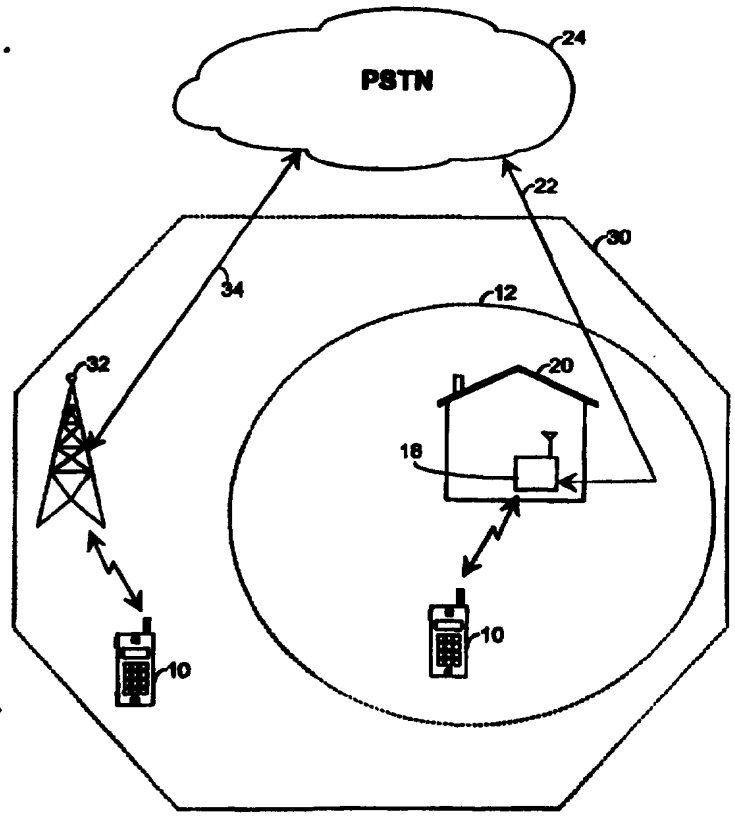
(54) Title: INDEPENDENT VOLUME CONTROL FOR MULTI-SYSTEM RADIO TELEPHONE

(57) Abstract

A multi-system radio telephone (10) operable in at least first and second radio communication systems includes an apparatus executing a method for controlling audio output volume levels of the radio telephone. According to one embodiment, a multi-system radio telephone is operable in a conventional analog cellular system (30) and a conventional local cordless system (12). The multi-system radio telephone includes two distinct memory areas (84, 86) for storing representations of volume levels for each of the respective radio communication systems. After the radio telephone determines which radio communication system (cellular or cordless) will be used for a particular radio communication session, the corresponding memory area is read to determine a default volume level for that radio communication system. The speaker (44) is then set to that particular volume level. During the communication session the user is also able to modify the volume level through conventional interaction with volume adjustment buttons (52, 54). If an indication for such a modification is detected, a representation of the new volume level is stored in the appropriate memory area in place of the old default volume level representation, and the speaker (44) is set to the new default volume level for that particular radio communication system. A visual representation of the volume level is also presented on the radio telephone display (58). This independent volume control method will provide the user with automatic volume control which is sensitive to the type of communication system being used during each communication session.



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INDEPENDENT VOLUME CONTROL FOR MULTI-SYSTEM RADIO TELEPHONE

BACKGROUND OF THE INVENTION

The present invention relates generally to the field of radio telephones, and more specifically, to the field of volume control in multi-system radio telephones.

A multi-system radio telephone is a radio telephone capable of operation in two or more different communication systems. As an example, one type of multi-system radio telephone is capable of operating in the conventional analog cellular system as well as a local cordless system. Such a telephone typically searches first for a local cordless base station radio signal in a particular frequency range. If such a local base station radio signal is detected, it is assumed that the radio telephone is within range (inside the coverage area) of a local cordless base station attached directly to a public switched telephone network (PSTN) land line,

through which radio air time is typically free (or at least lower priced) to the user of the radio telephone. If the radio telephone is outside the local cordless coverage area, the radio telephone searches for a conventional cellular system radio signal. Thus, the multi-system radio telephone is capable of communicating in either a conventional analog cellular system or a conventional local cordless system.

One problem associated with multi-system radio telephones relates to volume control of the telephone audio output. The conventional process of controlling volume for a multi-system radio telephone is particularly troublesome and inconvenient for a user. Typically, there is a difference in received signal levels between the two (e.g., cellular/cordless) radio communication systems. While cellular system radio signals are often affected by changes in transmission distance and various types of interference, cordless system radio signals are also affected by the quality of the associated PSTN land line. Furthermore, as a radio telephone moves from one location to another, environmental background noise may render it necessary for the user to adjust the volume of the radio telephone audio output.

The typical multi-system radio telephone has a volume adjustment mechanism which allows the user to set and modify the volume level for a communication session. While this simple functionality may be adequate for single-system radio telephones, it is a source of inconvenience for users of multi-system radio telephones. Because of the differences in received signal levels between different radio communication systems, it often becomes necessary for the user to modify the volume level every time the multi-system radio operates in a different radio communication system. If a user fails to remember to modify the volume when changing radio communication systems, the volume may be painfully high or so low that portions of a conversation are misunderstood or not perceived at all. Furthermore, because portable radio telephones are used in a variety of potentially hazardous situations, such as driving an automobile, it may often present in increased level of risk to require that user change volume levels for each change to a different radio communication system.

There is, therefore, a need in the industry for a method and an apparatus for addressing these and other related, and unrelated, problems.

SUMMARY OF THE INVENTION

Briefly described, the present invention includes a method and an apparatus for a multi-system radio telephone operable in at least first and second radio communication systems for controlling volume levels of the radio telephone audio output. In its most preferred embodiment, as an example, the multi-system radio telephone is operable in a conventional analog cellular system and a conventional local cordless system. The multi-system radio telephone includes two distinct memory areas for storing representations of volume levels for each of the respective radio communication systems. After the radio telephone determines which radio communication system (cellular or cordless) will be used for a particular radio communication session, the corresponding memory area is read to determine a default volume level for that radio communication system. The audio output (through an internal ear speaker or remote external speaker) is then set to that particular volume level.

During the communication session the user is also able to modify the volume level through conventional interaction with volume adjustment buttons. If an indication for such a modification is detected, the audio output is set to the new volume level, and a representation of the new default volume level is stored in the appropriate memory area in place of the old default volume level representation. Also, a visual representation of the volume level is presented on the radio telephone display. This independent volume control method will provide the user with automatic volume control which is sensitive to the type of communication system being used during each communication session.

It is, therefore, an object of the present invention to provide an independent volume control method for a multi-system radio telephone.

Another object of the present invention is to provide an independent volume control apparatus for a multi-system radio telephone.

Yet another object of the present invention is to provide a method for storing in distinct memory areas representations of volume levels associated with multiple radio communication systems.

Still another object of the present invention is to provide a multi-system radio telephone volume control method for determining which radio communication system is associated with a current communication session and responsively selecting an associated default volume level.

Still another object of the present invention is to provide a multi-system radio telephone volume control method for monitoring a user input volume adjustment mechanism and responsively replacing representations of volume levels in distinct memory areas.

Other objects, features and advantages of the present invention will become apparent upon reading and understanding the present specification, when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram representation of a multi-system radio telephone environment showing a multi-system radio telephone in alternate locations in accordance with the preferred embodiment of the present invention.

FIG. 2 is a front view representation of the multi-system radio telephone of FIG. 1.

FIG. 3 is a block diagram representation of selected elements of the multi-system radio telephone of FIG. 1.

FIG. 4 is a flow chart representation of the method of the present invention, in accordance with the preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now in greater detail to the drawings in which like numerals represent like components throughout the several views, FIG. 1 shows a multi-system radio telephone 10 in alternate locations. In one instance, the multi-system

radio telephone 10 is shown located within a local cordless coverage area 12 communicating through radio waves with a local cordless base station 18 which is shown located inside a user dwelling 20, such as a residence. In the manner of a conventional cordless telephone base station, the local cordless base station 18 is connected through a public switched telephone network (PSTN) land line 22 to the PSTN 24. In a second instance, the multi-system radio telephone 10 is shown located outside the local cordless coverage area 12 but within a conventional cellular coverage area 30. A conventional cellular base station 32 is shown connected to the PSTN 24 through cellular land trunk 34 and shown communicating through radio waves with the multi-system radio telephone 10 in the second instance. According to one multi-system arrangement, the multi-system radio telephone 10 communicates with other users in the PSTN 24 through the local cordless base station 18 while located within the local cordless coverage area 12. Otherwise, the multi-system radio telephone 10 communicates through the cellular base station 32 while located within remaining areas of the cellular coverage area 30.

FIG. 2 shows a front view representation of the multi-system radio telephone 10. The appearance of the multi-system radio telephone 10 is very much the same as that of a conventional cellular telephone. Extending through an outer casing 40 are speaker holes 42 which are located in front of a speaker 44 which is located inside the outer casing 40, thus being represented in dotted lines. Likewise, microphone holes 46 are shown in front of internally located microphone 48. Elements capable of receiving tactile user input are a keypad 50, up volume button 52, and down volume button 54. Finally, an antenna 56 protrudes from one end of the outer casing 40, and a display 58 is shown above the keypad 50.

FIG. 3 shows a block diagram representation of selected elements of the multi-system radio telephone 10. Connected to the antenna 56 is a radio frequency / intermediate frequency (RF/IF) circuit 64 which is connected to a baseband controller circuit 66. The baseband controller circuit 66 is connected to a speaker amplifier circuit 70 which is connected to the speaker 44. Also, though not shown,

the amplifier circuit 70 is connected to a jack for connection to an external speaker. The baseband controller circuit 66 is also connected to a microphone amplifier circuit 72 which is connected to the microphone 48. A central processing unit (CPU) circuit 74 is also connected to the baseband controller circuit 66 and the RF/IF circuit 64. A memory resource 76 with a cordless memory area 84 and a cellular memory area 86 (distinct memory areas for storing respective volume level representations) and an input/output (I/O) controller circuit 78 are also connected to the CPU circuit 74. The keypad 50 and display 58 are connected to the I/O controller circuit 78. Finally, up volume switch 80 and down volume switch 82 (attached to buttons 52, 54 of FIG. 2) are shown also connected to I/O controller circuit 78.

In a typical manner, radio signals received by the antenna 56 are supplied to the RF/IF circuit 64 which, in general, provides duplexing, modulation/demodulation, filtering, gain control, transmit power control, frequency tuning and other associated functionality. Subsequently, resulting baseband signals are supplied to the baseband controller circuit 66 which, in general, provides electronic audio volume control, audio input/output switching, and other audio processing functions, including compressing, expanding, limiting, filtering, summing and selectively filtering dual tone multi-frequency (DTMF) tones, supervisory audio (SAT) tones, signaling data, and wide band data. The speaker amplifier circuit 70 receives volume controlled audio signals from the baseband controller circuit 70 which are used to drive the speaker 44 (or, alternatively, any externally connected speaker (not shown)). Conversely, signals received by the microphone 48 are amplified by the microphone amplifier circuit 74 before being supplied to the baseband controller circuit 66.

Operations of both the RF/IF circuit 64 and the baseband controller circuit 66 are directed by the CPU circuit 74 which also interacts with the memory 76 and the I/O controller circuit 78. The I/O controller circuit 78 provides output to the display 58 for viewing by the user and receives input from the keypad 50. Input is also received from the user through the switches 80, 82. Periodically, but very

frequently, the switches 80, 82 are checked for changes from their normal states. Thus, the buttons 52, 54 (FIG. 2) and switches 80, 82 function as volume modification indicators generating volume modification indications in the form of switch movements. After an indication is detected, the CPU circuit 74 instructs the baseband controller circuit 66 to modify the speaker volume accordingly. The CPU circuit 74 also stores a representation of the new volume level in memory 76, as explained below. The structural and conventional operational details of each of the functional blocks of FIG. 3 would be readily understood by those reasonably skilled in the art after review of this disclosure.

FIG. 4 shows a flow chart representation of the method of the present invention, in accordance with a preferred embodiment of the present invention. Referring to FIG. 4, as well as FIGS. 1 and 3 for a view of elements of the present invention, after beginning in step 100, the multi-system radio telephone 10 determines in step 102 which radio communication system (e.g., cellular or cordless) will be used for a communication session. If the cordless system (corresponding to the local cordless base station 18 and PSTN land line 22) is to be used, the CORDLESS branch of decision block 104 is followed so that the cordless memory area 84 of memory 76 is read by the CPU circuit 74 according to step 106. The contents of the memory areas 84, 86 are initialized with initial default values (each memory area 84, 86 containing a representation of a speaker volume level) during an initialization stage (not shown). Subsequently, as explained below, the default values are selectively updated. Through communication with the baseband controller circuit 66, the CPU circuit 74 effects a setting of the volume level of the audio output (through the speaker 44 or any externally connected speaker), as shown in step 108. Then, the switches 80, 82 are monitored for volume modification indications at step 110. If no indications are detected, the NO branch of decision block 112 directs operation to decision block 118 where operation is looped back to step 110 until the process is terminated at step 120. Otherwise, the YES branch of decision block 112 is taken to step 114 where the volume level of the audio output is modified upward or

downward based upon the detected indication. Then, in step 116, a representation of the new volume level is stored in the cordless memory area 84 so that a new default volume level for cordless radio communication is defined, and the new volume level is shown on display 58. Subsequently, operation loops back up to step 110 as shown.

If, on the other hand, the cellular system (corresponding to the cellular base station 32 and cellular land trunk 34) is to be used for a communication session, the CELLULAR branch of decision block 104 is followed so that the cellular memory area 86 is read according to step 122. Subsequently, operation proceeds with steps 124 - 134 in a manner similar to that of steps 108 - 118 with the exception that the cellular memory area 86 is utilized instead of the cordless memory area 84. In one embodiment of the present invention, the described volume control method continues (i.e., a "communication session" lasts) throughout a period during which the multi-system radio telephone 10 is ready and able to send or receive radio signals to or from a particular radio communication system. Other embodiments are also contemplated which include system handoffs during telephone calls, in which case the disclosed method is repeated from the beginning to read another memory area for setting the audio output to a potentially different volume level.

While the embodiments of the present invention which have been disclosed herein are the preferred forms, other embodiments of the present invention will suggest themselves to persons skilled in the art in view of this disclosure. Therefore, it will be understood that variations and modifications can be effected within the spirit and scope of the invention and that the scope of the present invention should only be limited by the claims below. Furthermore, the equivalents of all means-or-step-plus-function elements in the claims below are intended to include any structure, material, or acts for performing the function as specifically claimed and as would be understood as substitutes by persons skilled in the art.

We claim:

CLAIMS

1. A method of controlling volume levels of audio output of a radio telephone operable in first and second radio communication systems, said method comprising the steps of:

storing in a first memory area a representation of a default volume level for communication in the first radio communication system;

storing in a second memory area a representation of a default volume level for communication in the second radio communication system;

determining which radio communication system of the first and second radio communication systems is associated with a current communication session;

in response to determining that the first radio communication system is associated with the current communication session,

reading from the first memory area the stored representation of the default volume level for communication in the first radio communication system, and

setting the audio output of the radio telephone to the default volume level for communication in the first radio communication system; and

in response to determining that the second radio communication system corresponds to the current communication session,

reading from the second memory area the stored representation of the default volume level for communication in the second radio communication system, and

setting the audio output of the radio telephone to the default volume level for communication in the second radio communication system.

2. The method of claim 1, further comprising steps of

monitoring a user volume modification indicator for a user volume modification indication during the current communication session; and

changing the volume level of the audio output of the radio telephone to a new volume level in response to detecting a user volume modification indication.

3. The method of claim 2, wherein the user volume modification indicator includes at least one button switch.

4. The method of claim 2, further comprising the step of displaying a visual indication of the new volume level in response to detecting a user volume modification indication.

5. The method of claim 2, further comprising steps of

in response to determining that the first radio communication system is associated with the current communication session and detecting a user volume modification indication, storing a representation of the new volume level in the first memory area in place of the default volume level for communication in the first radio communication system; and

in response to determining that the second radio communication system is associated with the current communication session and detecting a user volume modification indication, storing a representation of the new volume level in the second

memory area in place of the default volume level for communication in the second radio communication system.

6. A radio telephone volume control apparatus for controlling audio output volume levels of a radio telephone operable in first and second radio communication systems, said radio telephone volume control apparatus comprising:

first memory means for storing a representation of a volume level for communication in the first radio communication system;

second memory means for storing a representation of a volume level for communication in the second radio communication system;

means for writing to said first memory means a representation of a default volume level for communication in the first radio communication system and for writing to said second memory means a representation of a default volume level for communication in the second radio communication system;

means for determining which radio communication system of the first and second radio communication systems is associated with a current communication session;

means, in response to determining that the first radio communication system is associated with the current communication session,

for reading from the first memory area the stored representation of the default volume level for communication in the first radio communication system, and

for setting the audio output volume level of the radio telephone to the default volume level

for communication in the first radio communication system; and

means, in response to determining that the second radio communication system is associated with the current communication session,

for reading from the second memory area the stored representation of the default volume level for communication in the second radio communication system, and

for setting the audio output volume level of the radio telephone to the default volume level for communication in the second radio communication system.

7. The apparatus of claim 6, further comprising

indicator means for receiving volume modification user input and for responsively generating a user volume modification indication;

means for monitoring said indicator means for a user volume modification indication during the current communication session; and

means for changing the audio output volume level of the radio telephone to a new volume level in response to detecting a user volume modification indication.

8. The apparatus of claim 7, wherein said indicator means includes at least one button switch.

9. The apparatus of claim 7, further comprising means for displaying a visual indication of the new volume level in response to detecting a user volume modification indication.

10. The apparatus of claim 7, further comprising

means for, in response to determining that the first radio communication system is associated with the current communication session and detecting a user volume modification indication, writing a representation of the new volume level in said first memory means in place of the default volume level for communication in the first radio communication system; and

means for, in response to determining that the second radio communication system is associated with the current communication session and detecting a user volume modification indication, writing a representation of the new volume level in said second memory means in place of the default volume level for communication in the second radio communication system.

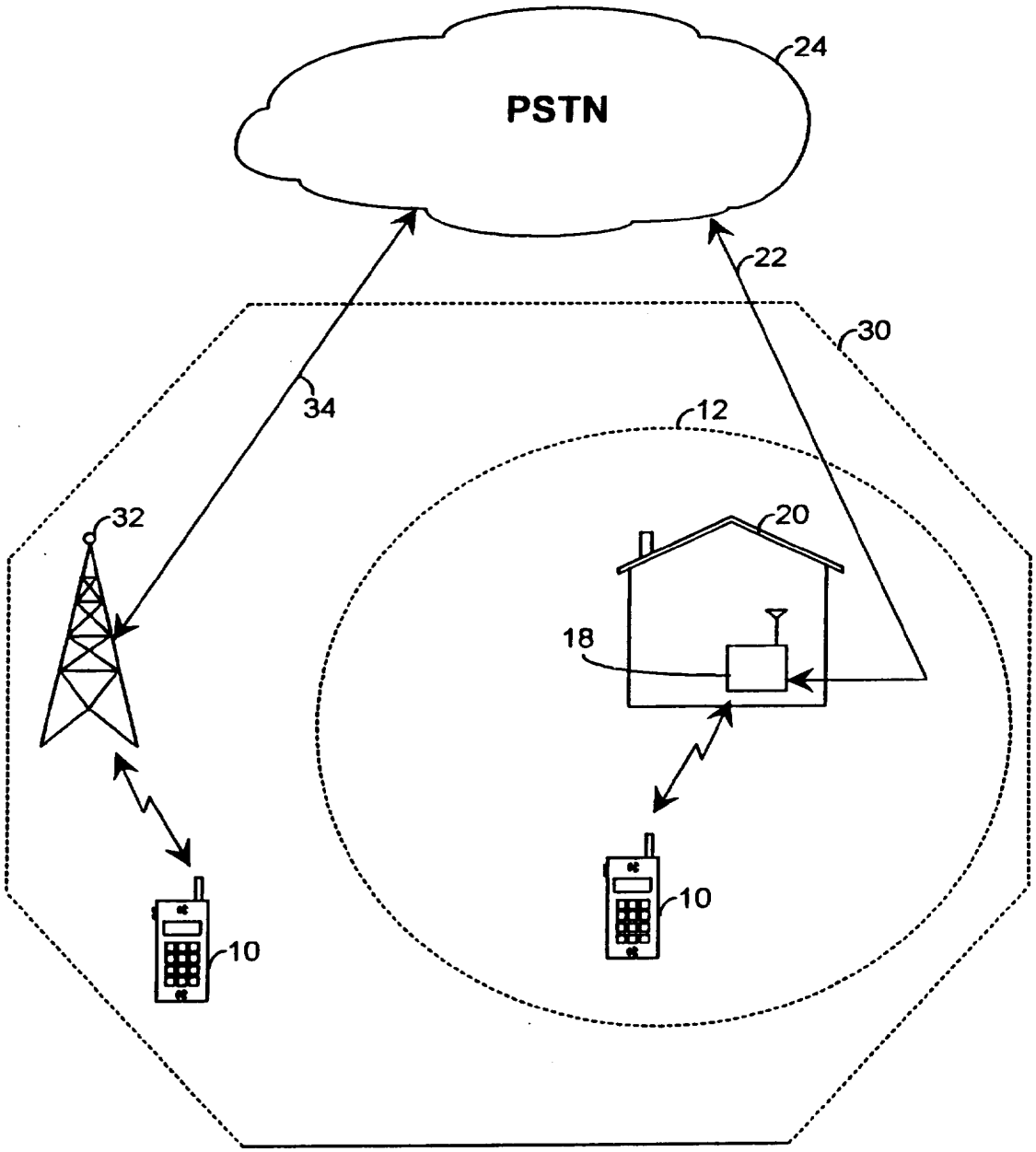


FIG. 1

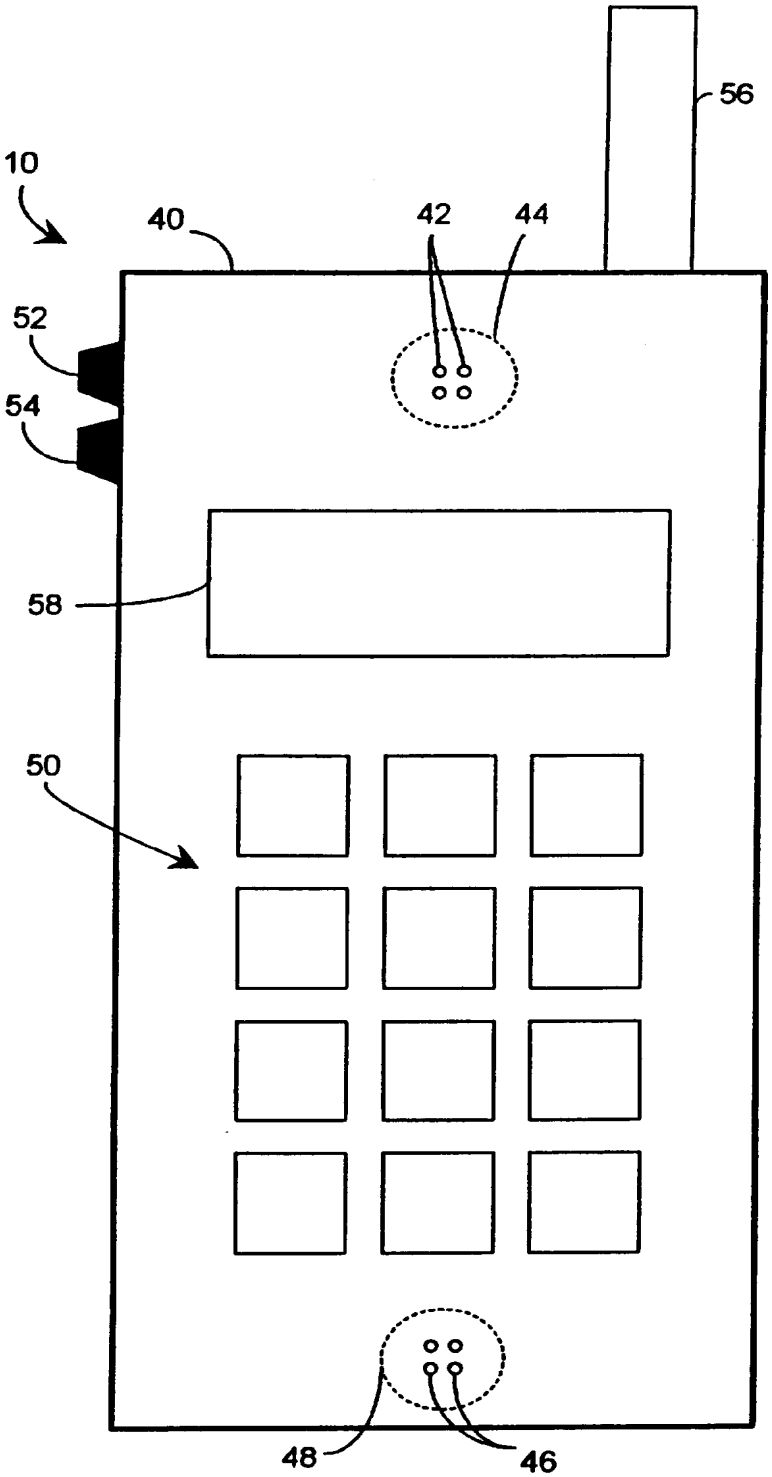
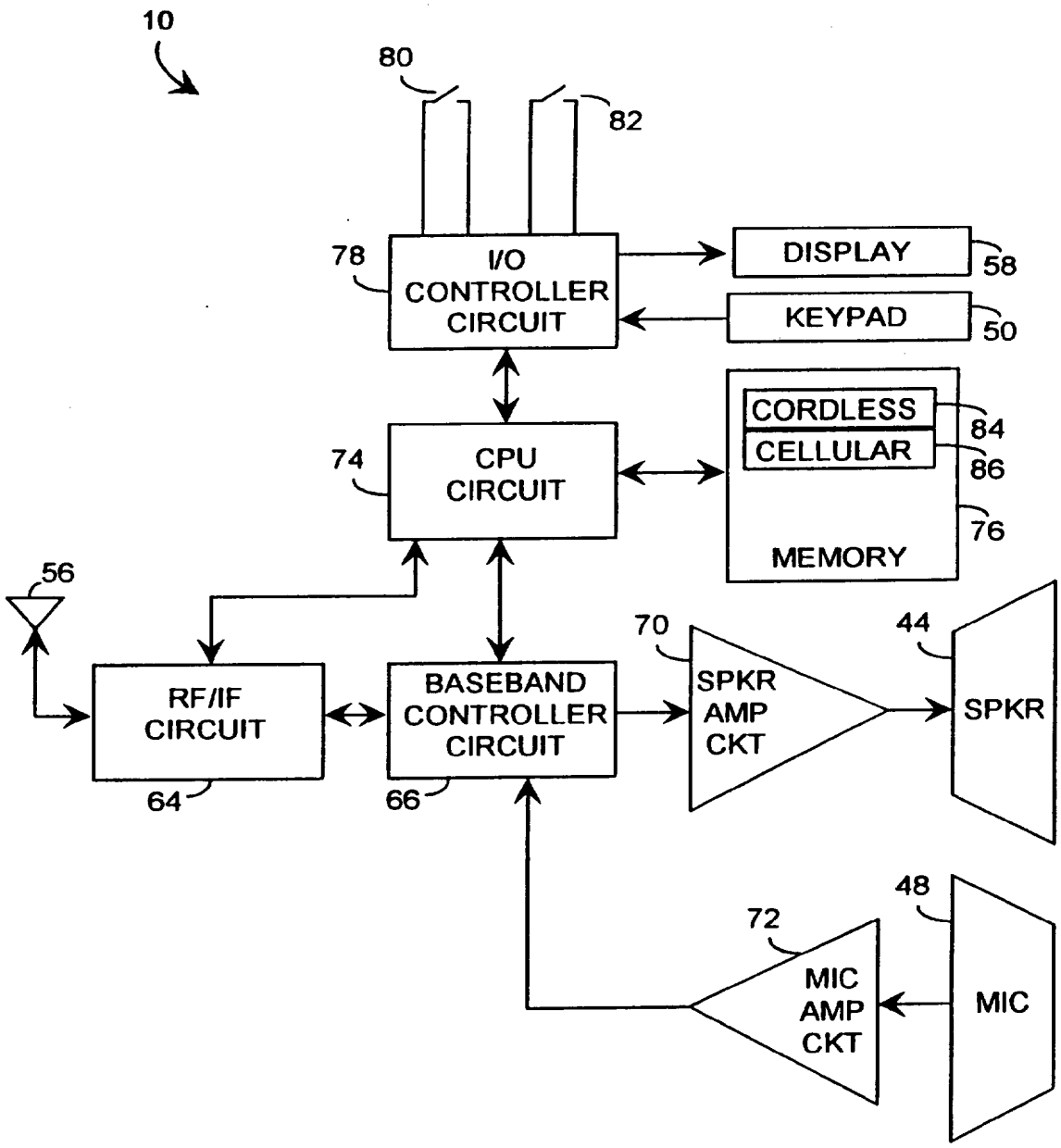


FIG. 2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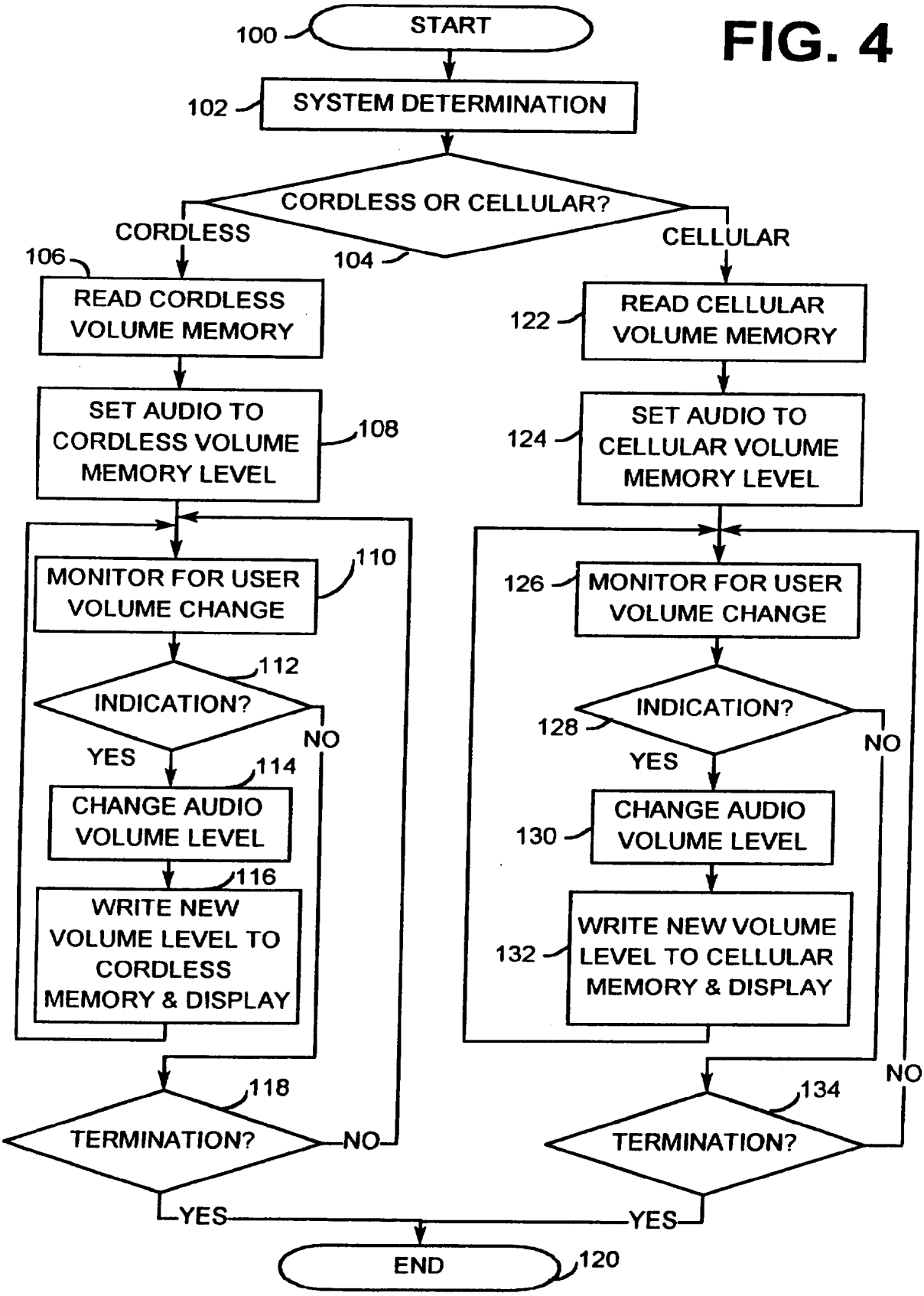
80
82
78
I/O CONTROLLER CIRCUIT
DISPLAY
58
KEYPAD
50
CORDLESS
84
CELLULAR
86
74
CPU CIRCUIT
76
MEMORY
56
70
44
RF/IF CIRCUIT
BASEBAND CONTROLLER CIRCUIT
SPKR AMP CKT
SPKR
64
66
48
72
MIC AMP CKT
MIC

FIG. 3

FIG. 4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CELLULAR
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SET AUDIO TO CORDLESS VOLUME MEMORY LEVEL
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MONITOR FOR USER VOLUME CHANGE
110
INDICATION?
112
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NO
CHANGE AUDIO VOLUME LEVEL
114
WRITE NEW VOLUME LEVEL TO CORDLESS MEMORY & DISPLAY
116
122
READ CELLULAR VOLUME MEMORY
124
SET AUDIO TO CELLULAR VOLUME MEMORY LEVEL
126
MONITOR FOR USER VOLUME CHANGE
128
INDICATION?
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NO
130
CHANGE AUDIO VOLUME LEVEL
132
WRITE NEW VOLUME LEVEL TO CELLULAR MEMORY & DISPLAY
118
TERMINATION?
NO
YES
134
TERMINATION?
NO
YES
END
120

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/14727

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04M 11/00; H04B 1/40
US CL :455/33.1, 186.1; 379/58
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B. FIELDS SEARCHED

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NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ---- Y	US, A, 4,924,193 (SAITO ET AL) 08 May 1990, col. 1, lines 12-29, 35-38, col. 2, lines 26-33, 47-56, col. 3, lines 7-47, col. 4, lines 29-60, figure 5.	1-3, 5-8, 10 ---------- 4, 9
Y	US, A, 4,661,994 (TANAKA ET AL) 28 April 1987, col. 6, lines 19-40.	4, 9
A	US, A, 5,204,971 (TAKAHASHI ET AL) 20 April 1993, see figure 3.	1-10
A	US, A, 4,495,652 (LESLIE) 22 January 1985, abstract, figures 2a and 2b.	1-10

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